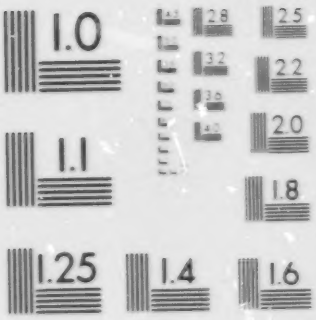

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This paper provides an overview of the information currently available on the prospects of electronic work at home. The first major section examines the technological environment that makes electronic home work possible. Central and dispersed computer facilities, internal and external means of communication, work stations, software, and security factors are studied from the standpoints of present and future technology and from the point of view of a work organization considering the design of a system that could accommodate electronic home workers. The second major section considers likely human implications of electronic home work. These are classified as costs and benefits (interpreted broadly as disadvantages and advantages) to the worker, to the employer, and to society. The paper concludes that the electronic cottage option has costs and benefits that depend on particular circumstances and their interaction and that the option offers the potential to improve the quality of many workers' lives. (YLB)

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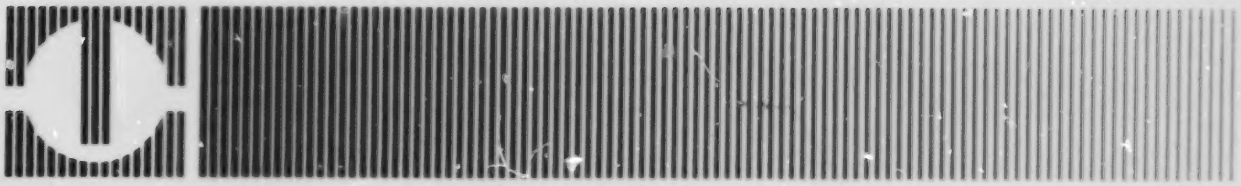

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The University of Tennessee College of Education

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The Electronic Cottage

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FOREWORD

The Office for Research in High Technology Education at the University of Tennessee, Knoxville, is conducting a program of work on high technology and its implications for education. Funded by the U.S. Department of Education's Office of Vocational and Adult Education, the program addresses the skill requirements and social implications of a technology-oriented society. Issues concerning computer literacy and computer applications are a focus of the program. The balance between the liberal arts and technological skills and the complementary roles they play in enabling people to function in and derive satisfaction from today's high-technology era are also addressed. The program's efforts are targeted at secondary schools, two-year post-secondary institutions, community colleges, universities, industrial training personnel, and other education and training groups.

The program consists of three major components:

At Home In the Office Study - At Home In the Office is an experiment that has placed office workers and equipment in the workers' homes to determine (1) what types of office work can effectively be done at home and (2) the advantages and disadvantages of home work stations. The implications for educators, employers, and employees will be significant, as work at home offers a possible avenue of employment for people living in rural areas, parents of pre-school children, handicapped individuals, and others.

COMTASK Database - COMTASK is a model of a computerized task inventory for high-technology occupations. The outcomes of the COMTASK system include a sampling of task analyses, the demonstration of how these task analyses can be rapidly updated, a manual for conducting task analyses to provide data for the system, and a guide to using the system.

State-of-the-Art Papers - A series of nine papers is being developed to address high technology and economic issues that are of major concern to education. Nine working titles have been selected:

- The Changing Business Environment: Implications for Vocational Curricula
- Computer Literacy in Vocational Education: Perspectives and Directions
- Computer Software for Vocational Education: Development and Evaluation
- Educating for the Future: The Effects of Some Recent Legislation on Secondary Vocational Education
- The Electronic Cottage
- High Technology in Rural Settings
- (Re)Training Adults for New Office and Business Technologies
- Robots, Jobs, and Education
- Work in a World of High Technology: Problems and Prospects for Disadvantaged Workers

Abstract

This paper provides an overview of the information currently available on the prospects of electronic home work. The first major section examines the technological environment which makes electronic home work possible. Central and dispersed computer facilities, internal and external means of communication, work stations, software, and security factors are examined from the standpoints of present and future technology and from the point of view of a work organization considering the design of a system that could accommododate electronic home workers.

The paper's second major section examines likely human implications of electronic home work. These are classified as costs and benefits (interpreted broadly as disadvantages and advantages) to the worker, to the employer, and to society at large. Costs and benefits interact with each other and are determined by particular circumstances. However, it appears that the electronic home work option has the potential to improve the quality of life of many workers.

About the Authors

Martin Morf, who was primarily responsible for the paper's introduction and second major section, is a registered psychologist and has conducted research in the psychology of work. In a recent issue of The Futurist, he outlined eight scenarios for work in the future, one of which was "The Electronic Cottage." He has written a number of articles dealing with the relationship between work performance and quality of life and with work-related dimensions of extroversion and introversion.

Philip Alexander, who was primarily responsible for the paper's first major section, is a registered professional engineer. He has been active in research and consulting work involving communications, alternative futures, and electromagnetic field analysis as applied to electric power distribution and microwave structures. He has written numerous articles, including "Lifestyle Implications of Alternative Energy Futures," and "Study of Business Telecommunications Systems via Satellite."

About the Editors

This paper has been prepared as part of a series of state-of-the-art papers edited by Lillian A. Clinard, an associate director of The University of Tennessee's Energy, Environment, and Resources Center (EERC), and Mary R. English, a research associate at EERC. The editors, who have been on assignment to the Office for Research in High Technology Education, were responsible for selecting the series' authors, reviewing and coordinating external reviews of the papers, and preparing the papers for release.

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INTRODUCTION

The Inuit are said to have about two dozen words for "snow," that most important aspect of their environment. We soon may have an equal number of terms for working in locations other than the traditional central workplace: electronic cottage, telework, virtual office, telecommuting, remote office work, remote work station, residential office, decentralized work. . . . Probably the best known of these terms is the electronic cottage introduced by Toffler in his 1980 bestseller, The Third Wave.

This new way of working is enabled by the integration of today's telecommunication and computer technology. By combining advances in these two areas, we now have systems which make it possible to communicate, retrieve, store, and manipulate information on a global scale. The average citizen can already experience the fruits of these advances: for example, a telephone call to Japan or Europe is likely to be established quickly and automatically and may cost less than $10.

The combination of telecommunications and computers can lead to "telecommuting" (Nilles, Carlson, Gray, & Hanneman, 1976) -- to people working close to home or at home; to the efficient movement of information rather than the inefficient movement of people. We have all admired the downtown office towers in big cities -- the prestige monuments large corporations have built to let the world know that they plan to be around for awhile. But the days of these cathedrals of work may be numbered. While large data bases are likely to remain centralized -- i.e., while their electronic maintenance and updating will probably continue to rely on some type of central control -- more of the actual information processing

is likely to be done by people in geographically dispersed locations.

Many work organizations have begun to experiment with electronic home work. Their experiences have not been uniformly successful. On the contrary, a number of hurdles have emerged. It remains to be seen whether these are merely transition problems or whether they are intrinsic to electronic home work.

Although corporations have shown widespread interest in the possibilities of this type of work, it is so recent a development that little systematic and thorough research has been done on it. So far it has been addressed primarily through conferences and by anecdotal articles in the popular press, especially the burgeoning microcomputer literature. This puts a great reliance on the few, formal pioneering efforts to study work at home. These include a number of articles and reports by Olson (1982, 1983), Kingston (1983), and Pratt (in press). The book by Nilles et al. (1976) is a classic on decentralized work in general.

There are, however, substantial bodies of literature that provide a basis for approaching the phenomenon of home work from the standpoint of one of its main determinants — available technology — and from the standpoint of its potential effects. The latter are of interest to such disciplines as economics and business administration, as well as to the practitioners of industrial-organizational psychology who look beyond the bottom line to such things as the costs and benefits to workers that may not have a direct bearing on productivity and profitability. Literature from engineering, economics and business, psychology, and the social

sciences in general is thus relevant to the task of evaluating the prospects of the electronic cottage.

This paper's objective is to provide an overview of some of the basic and generally available information on electronic home work. This is an area of rapid change, an area which is generating mountains of commentary reflecting first impressions, personal experiences, and dramatic examples. The intent here is to approach the topic with a definite framework and to focus on information that has a relatively long half-life. The two main categories of our framework are (a) the technology available for electronic home work, and (b) the human implications of this type of work.

Many factors affect the ways in which work is organized. These factors fall into two broad categories, often described as social factors and material factors.

Among the social factors, the values of workers, managers, and society at large may have the biggest effect. In recent years, the values of the labor force have changed from a work ethic to a romantic rejection of work and now to a relatively more moderate position between these two extremes. It seems fair to say that many employees would prefer to live in the country rather than the city, and that many would like the fewer constraints made possible (in principle) by home work. Some managers espouse authoritarian values and worry about how they would supervise employees who were working at home. Organized labor and women's organizations fear that electronic home work will make union organizing activities more difficult and will thus lead to exploitation, particularly of women.

Material factors, on the other hand, are visible external conditions. For example, a company operating in a pleasant suburban area may find it easier to attract employees than a company located in a crime-ridden downtown area, and the latter thus might be more interested in the electronic home work option. Available labor resources also depend on the state and local education system. Are the schools turning out computer-literate future workers? To what extent would the organization have to train its labor force in the basics of computer use, and what would be the costs of such training programs? The regulatory environment can play a major role (for while laws and regulations are not material, their consequences certainly can be): Are there statutes prohibiting or inhibiting home work? Or, on the other hand, are there statutes which give favorable tax treatment to those who invest in the technology required for electronic home work? But the most important material factor is the technology itself, particularly in terms of its sophistication and costs.

We deal with technology first, then, because we see it as perhaps the most crucial determinant of electronic home work. Philosophers and social scientists have long been faced with the question of whether external conditions shape human values or vice versa. This is the Marx/Weber debate, the debate of those who first analyze the system and then look at its effects on individuals versus those who start with individuals imbued with certain values, such as the Protestant ethic, and then concentrate on the way these individuals alter the system. Is this a chicken-and-egg debate? Certainly either position can be defended. But the first position (that of the system's effect on individuals) is assumed here, out of a

conviction that new external conditions -- in particular, new technologies based first on the tool, then on the machine, and today on computers and telecommunications -- have had and will continue to have major impacts on people.

We then turn to the human implications of electronic home work -- specifically, to its costs and benefits, defined broadly as advantages and disadvantages -- for the worker, the work organization, and society at large. Throughout, however, it should be remembered that external conditions and people always interact in complex ways and that these distinctions are thus useful mainly for analytical purposes.

SOME TECHNOLOGICAL DETERMINANTS OF ELECTRONIC HOME WORK

The technological aspects of work-at-home systems are approached here by describing the state of the art of the relevant equipment. This is followed by a fairly conservative projection of types of capability that can be expected to be available within the time of deployment of systems which, as of August of 1984, are in their earliest conceptual stages. The specific implications for the electronic cottage are then noted in terms of the work station environments which could be implemented. Lastly, the detailed considerations which must be taken into account are developed to the degree allowed by the constraints of this report.

The Present State of Technology

Since the electronic cottage concept (Toffler, 1980) arose from considering the directions in which computers and telecommunications are developing, these are the main areas of technology which should be surveyed. Some key considerations with this technology are discussed below.

Computer facilities. Information-processing equipment is rapidly becoming indispensable to modern businesses. Few organizations have not yet taken the plunge into the computer age, and most of these recognize that the transition is inevitable. For them, the timing of the change is the only remaining uncertainty.

Depending on the organization's size, the computer facilities may range from a mainframe or large central computer to a single desktop personal computer. In addition to raw computing power (typically expressed

in terms of megabytes of memory and megainstructions executed per second), an important feature of this technology is its interconnectability — i.e., the degree to which distinct computers can readily exchange information with one another. The firm's equipment may consist of a few microcomputers, or it may include communication links between a major in-house computer and external service bureaus. (See the sections below on internal and external communications.)

Today's mainframe computers are often multi-gigabyte memory systems which accommodate hundreds of users at terminals scattered over extended organization sites (and beyond). When such systems are used near the limits of their capacities, there are quite noticeable variations in their performances (as measured by response time). In some cases, batch operations are shifted as a matter of policy to off-peak operating hours. In other cases, smaller capacity local processors are used to allow stand-alone execution of computational activities that do not require extensive access to the mainframe unit's resources. The main system may be accessed for database information or for uses requiring large memory capacity. This strategy to divert the computational load away from the central computer (off-loading) can be used with significant peripheral processors (consisting of other smaller mainframes or minicomputers), personal computers, or intelligent terminals. The mainframe computer's size can be selected to accommodate the load that the organization allocates to it. Costs for acquiring or leasing such a system vary widely.

For organizations whose computer requirements are less demanding or have been designed with decentralization in mind, smaller computers

(minicomputers and personal computers) located at scattered sites may suffice. Their collective capacity can rival that of some mainframe computers. Sometimes such systems evolve from a single desktop processor to an array of special-purpose systems located in various departments. Invariably, the need arises to exchange data among separated units.

Internal communications. When located on the main corporate site, the terminals used to access mainframe computers are usually connected by hard-wired paths. If the wiring system is a general-purpose one which allows a variety of equipment (e.g., terminals, printers, facsimile [FAX] units, etc.) to be attached, it is usually referred to as a local area network (or LAN). Standards for LANs are evolving, and firms with a complement of equipment from a particular manufacturer use the interconnection scheme of that supplier. Some such arrangements are Xerox's "Ethernet," IBM's "Systems Network Architecture (SNA)," and Northern Telecom's "Open World." Today's market reveals an increasing array of office equipment which claims to operate in the several LAN environments.

Some of the newer private automatic branch exchanges (telephone control centers within firms, or PABXs) are capable of switching data as well as voice communications from point to point within the organization. Recent developments in telephone-switching technology have produced an electronic stored program version of this equipment, sometimes called a computerized automatic branch exchange (CABX). Using such systems to handle the flow of data within an organization means expanding the voice-oriented telephone system to handle computer data. It seems to

offer economies by avoiding the extra set of wires, cables, or fiber optic links that a LAN requires. However, some people question whether a system designed first to handle voice traffic can be adapted to also efficiently handle digital data. It can be expected that each new generation of telephone-switching equipment will incorporate greater efficiencies than the last and will consider more aspects of the intended use.

There are also electronic boxes, or interfaces, that allow equipment designed according to one set of electrical signaling standards, or protocols, to be connected to a network which operates according to a different set. This eases the problem of early equipment obsolescence due to rapidly changing technology, but it does complicate the decision about whether to convert to a new generation of equipment, since the earlier models' lifespans become extended.

For premises with a number of buildings, microwave relay systems may be used to link sites separated by a few hundred yards. These systems have the necessary transmission capacity to handle bulk data transfers between mainframe computers as well as more modest voice and data communications loads. Microwave relay systems have a particular advantage over hard-wired (cable) connections, in that they require less construction and installation effort. This makes them much more flexible (that is, they can be readily relocated as communication needs change) and less susceptible to escalated construction costs due to inhospitable terrain or major physical obstacles in the communications path.

For longer distances within urban areas, lines leased from the local public telephone company are usually the most cost-effective means of

obtaining inter-site communications. More and more connections are being installed that can handle data at quite high transfer rates. These connections make use of conventional coaxial cable in many instances, but the current trend is toward fiber optic links. The latter have a much larger overall data-handling capacity for comparable installation costs and require much less space. Several field trials have demonstrated their utility, not only in public networks for new data-inclusive services (Bell, 1984) but also in private high-capacity systems.

Some private data networks make use of satellite links. Satellite Business Systems (SBS) was one of the earliest firms to provide clients with high-rate data services as well as voice and video transmission services over satellite links. These satellite links are particularly valuable for communicating with highly remote or otherwise difficult-to-access locations. Their relative cost-effectiveness depends on the availability of alternative land-based communications paths and on the expected communication traffic volume.

External communications. Data networks are available which allow mainframe computers at widely separated locations (e.g., in different cities) to exchange information. These networks may consist of leased lines which have been designed or conditioned for high-speed data transfer, or they may be packet-switching networks where charges are allocated essentially on the basis of the amount of information transmitted. The latter type of network arranges the data being handled into convenient groups of bits, or packets, which are interspersed among similar packets for other users. Extra "addressing" information bits are included as a

header to each packet so that it can be routed to its proper destination in the network. This approach allows the connecting wire paths to be shared as necessary among all the users, with the switching performed electronically by computers dedicated to operating the network. Packet-switching is a very economical and efficient approach when the number of users is extremely large and their communication requirements are varied.

Dataroute (in Canada) is a special-purpose network capable of providing leased lines, and there are several private long-distance communications firms in the United States (and CN/CP Telecommunications in Canada) which provide such services. Datapac, Tymenet, and Telenet are packet-switching networks which were developed commercially after the extensive pilot-testing activities of the U.S. Department of Defense's ARPANET, the original packet-switching network. These systems generally have some form of electronic mail available to their users, and some host processors support computer-mediated conferencing. The Ford Motor Company's "World Cars" have been designed in part on an internationally accessed computer system in which time zone differences at the various corporate design facilities are used to advantage to reduce peaks in the system's computational loads.

Telephone access to such systems from remote terminals is now widely used. Increasing hardware sophistication has produced a truly continuous range of terminal types that can be used over telephone connections — a range extending from terminals that are little more than typewriters to

independent computer systems of a high degree of complexity. An increasing number of units are coming onto the market with built-in devices which make telephone-based access quite routine. The need to have software to implement the terminal/central computer communication must be considered. This is discussed further below.

Work stations. Intelligent computer terminals with non-trivial amounts of memory capacity are now available as highly portable units selling for $700 to $1500. This means that computer systems with telephone ports can be accessed from any location which has telephone service of sufficient quality (i.e., freedom from noise and circuit interruptions). Such service is generally available throughout the industrialized world.

Word processing and many simple clerical tasks can be performed on a "dumb" terminal consisting of a keyboard, Video Display Unit, and a modem. The last of these can be defined as the minimum electronics necessary to enable the terminal to send keystrokes to, and receive characters from, the main computer. Such a simple work station is often termed a Video DisplayTerminal (VDT). Any hard copy to be generated can be produced on a printer at the main computer site. If required, a printer can be made available at the workstation location at a cost of from $300 (for a simple dot-matrix printer) to several thousand dollars (for a letter-quality unit with single-sheet feed capability). The decreasing prices of intelligent terminals may make the incorporation of editing capability within the terminal (to aid in decreasing the load on the main computer) more cost-effective. Such off-loading may be especially important when the number of work stations is large.

Computer access for some workers is mainly associated with database manipulation. This work activity is often implemented with dumb terminals, but the earlier comments about using local data-processing capacity to decrease the central facility's load apply. In this case, there is usually little need for hard copy at the terminal site, but an appreciable amount of locally available data storage is much more likely to be required. In this case, the basic cost of a terminal with the necessary computing and memory capacity (necessitating disk storage) starts at about $1500.

Technical workers may also be accessing a central computer from a terminal which is much like a word processing unit, since they are often preparing, editing, and running computer programs. Again, off-loading the main computer system can be useful and may be feasible if the nature of the calculations and the size of the required programs allow them to be accommodated in the workstation memory under stand-alone conditions.

Computer-intensive technical design activity and some graphics-oriented database development work require sophisticated high-resolution graphics terminals as output devices. Since such activities place a heavy demand on computer resources, off-loading the central computer should be considered. However, the associated terminal hardware costs can be driven upward from $10,000 by the cost of the stand-alone processor (which would often be a minicomputer).

Software. Currently available software can provide for practically all routine business data-processing operations on large mainframe systems. Among these, packages known as "expert systems" are currently being developed (Gevarter, 1983). These are technical or specialized

applications computer programs which have incorporated theories, rules, empirical data, and the best available judgment on questions normally arising in the course of these programs' use. Guidance on the processes implemented by such systems (which are typically analysis, simulation, or design aids) is obtained from appropriate experts; their approaches to the problem at hand are thus available to the user through the program. Because of the variety of alternatives which must be taken into account, and because of the quantity of empirical data which must often be included, such programs tend to be very large and only usable on computer systems with large amounts of on-line memory. However, one of the early attempts at producing such a system for facile man-machine communications (ELIZA) is now available for some of the more popular personal computers. It should be noted that the originator of ELIZA feels very strongly that it falls far short of being a true "expert system" (Weizenbaum, 1976). However, this has not prevented some from touting it as a useful tool in psychotherapeutic applications.

There is a great deal of software available for smaller systems used in a stand-alone mode with modest computational tasks. Packages are often custom-designed for the functions and equipment configuration specified by the client. Although a huge number of such applications programs might seem to be available as standard items — especially when the equipment is a type common in both business and home use — the features and capacities (e.g., the number of accounts receivable which can be accommodated in a bookkeeping package) will not be likely to suit the requirements of large businesses or departments. When these packages are found to have the basic

capability, the advantage of using one with which the potential home worker is already familiar should not be overlooked.

Communications software that facilitates data exchange among machines is a distinct category of computer programs. Special code exists (often written in an assembly language for more rapid execution) to accommodate many popular types of processors linked by various LANs. But because universal standards have not fully penetrated the user arena, care must be taken to ensure that the entire system is compatible in both the hardware and the protocols associated with the link (LAN) and the interacting operating systems.

Security. There is concern in many quarters over computer system security (Bernhard, 1982). Several cases of "amateurs" getting access to major computer systems from the public telephone network have recently received notoriety. There is also a fear that truly criminal computer system transgressions are alarmingly pervasive and that this fact is being hidden from the public. There are further fears that such crimes are responsible for hidden costs (e.g., in areas such as banking) which must ultimately be borne by consumers.

In the main, however, such breaches of computer system integrity have been due to lax or nonexistent security measures. It has been suggested that passwords which were simple default values and which were present when the system was installed were allowed to remain in effect in many of these instances. It has also been suggested that user-specified passwords are chosen on the basis of easy recall (such as a spouse's name, or the user's

initials in reverse order), a practice which could be very susceptible to trial-and-error code-breaking tactics.

Quite simple and inexpensive means can be implemented in, for example, the sign-on procedure to prevent account number/password format details from being revealed to someone trying to violate system security by entering random character sequences. There are several additional easily incorporated methods of improving computer security, but the weakest link may be human nature. Getting staff to fully utilize the provisions available to protect the system from unauthorized use (such as frequently changing passwords) is one remedy. Requiring multiple keys (in physical and/or software terms) to be used in concert by different personnel for gaining access to sensitive files is another. And an aggressive security system can also include measures to raise job satisfaction and thereby eliminate factors which tend to cultivate turncoat employees. Even more elaborate measures can be taken to improve the security of computer systems, but generally speaking, the suggested improvements relate more to utilizing a knowledge of human nature in a creative manner than to increasing hardware sophistication (Crichton, 1984).

The problem of unauthorized data interception during transfer between separated units is currently being addressed through coding. There is a national standard (the Data Encryption Standard) which tries to ensure that hardware is economically available to allow users to implement and change secret codes at their discretion. The level of protection is also specified. Protection levels are sometimes expressed in the terms of computation years necessary (on the average, on a large machine) for an aspiring transgressor to break the coding scheme.

Technology in the Future

Imagine a scenario in which an operator's work assignment for the day, the required data, and the necessary computer programs are transmitted from the central computer to his or her machine (down-loaded) overnight. Some of the preliminary tabulation and graphic organization of the data has been performed automatically by the down-loaded software. However, as the day's tasks are being articulated on the work station's voice synthesizer, the sequence is interrupted by the supervisor's voice (also synthesized), stating that there is an urgent meeting which this worker must arrange among the supervisor and several coworkers whose computerized calendars must be consulted for a common available time. After confirming the details of the meeting with three of the four other participants, the day's original tasks are begun.

There is a report to be edited from the Australia office, a task which requires adding the most recently generated poll results for a market survey on a proposed product. Then, the current rates on short-term investment notes from a representative sample of financial institutions must be obtained in order for a recommendation to be made regarding some of the firm's floating deposits. These recommendations will be examined and dispatched by the assistant director of finance from his computer terminal in his London hotel room. An electronic transfer of the funds will be made before the next change in rates is announced. At 10:30, our worker is feeding the baby while entering the poll information using the audio input unit. The synthesizer excuses itself for interrupting and reminds him that he had planned to meet his wife for brunch at the local plaza. . . .

This scenario includes several currently available features which have not yet achieved widespread penetration in business. Among these are voice recognition and synthesis, LAN communication between remote terminals and a firm's central network, and external database access. It seems likely that these functions and others on the market today will become more reliable and straightforward to use, and at lower costs per function, although the typical price paid per work station will increase somewhat.

Technology's rapid rate of change requires that any system design should consider what equipment is likely to be available in the future, to ensure that the design allows for capabilities that may become available only during system implementation. Without being unduly futuristic, the following sections sketch the type of technology expected on the market within a few years. Most of the concepts here are based on the authors' assessments of what continuing developments will bring, but where more formalized projections are used, literature citations are included.

Computer considerations. Although research on fifth-generation computer systems is now shifting into high gear, the inference-building machines currently being discussed in artificial intelligence literature should not be expected on the market for general business use before the middle of the next decade (Feigenbaum, 1983). However, augmented-capacity present-generation systems will be developed which implement primitive approaches to artificial intelligence. Thus, the next decade's electronic cottage developments can be expected to take place in the context of today's state-of-the-art mainframe computers with, at best, limited software capability to initiate machine intelligence. However, the

categorization among mainframe computers, minicomputers, personal computers, intelligent work stations, and so on will continue to become more blurred as more capacity is included in smaller packages.

Internal communications. Development activities on Very Large Scale Integration (VLSI) are now under way to make the necessary electronic chips available to customize office automation equipment for effective use with any foreseeable LAN automation equipment (Guthrie, 1984). The system designer mainly needs to be aware of development in the field of satellite communications in order to take full advantage of the most likely relevant technological advances.

Intensive activity to make available low-cost stations for reception of direct-to-home satellite broadcasting signals is now under way. Concerns about the lack of quality in the program material are putting a damper on the originally optimistic market penetration estimates. However, special-interest-group communications requirements for earth station equipment will be sufficiently great to lower costs enough to consider using this equipment, even in some of the simplest telecommuting tasks.

Private satellite networks are currently economically feasible for high-volume information transfers. Satellite system suppliers have developed sophisticated controlling strategies which can be used with equipment acquired at costs justifiable by the purchaser's immediate communication needs, even when these are quite modest.

External communications. The currently available means for ferrying data around the country (or the world) will continue to mature. More

commercial communications service firms will become available. The business community will gravitate toward those systems with sound service records. Although the ranking of competitors is not yet clear, the earliest established communications suppliers will have a definite advantage.

Work stations. In general terms, work stations will become more user-friendly, from the points of view of both the terminal's ergonomics and its associated software. Current research is determining the optimum values of the many parameters involved, and standards are being implemented throughout the world (e.g., Raouf, 1983). More local intelligence and computing capacity will be available, and large-scale integration will allow this to be done at lower cost per unit of capacity. Equipment will become more user-friendly due to the widespread incorporation of audio input/output subsystems (von Buchstab, 1982).

It should be noted here that a relatively small active vocabulary is required for speech recognition if a tree structure is imposed such that the system need only distinguish a limited set of mutually exclusive terms at each level of user access. Furthermore, lower level technical and clerical functions generally use a very limited vocabulary. Even higher management use of "expert systems" typically will be based on a modular concept, with each package having a limited applicability (e.g., to a particular technical design function or a particular financial analysis function) and therefore requiring only a restricted vocabulary. In addition, speech synthesis will be used where database access is to be performed with another activity (possibly one requiring manual dexterity), when the worker's attention must be diverted from the screen or keyboard.

Terminals for sophisticated graphic-design work and database development will probably evolve at a modest pace. There will be broader penetration of full-color capability and reasonable resolution graphics stations with flat (liquid crystal) displays should be on the market for about $2000 before the end of this decade.

Special-purpose and exotic workstation features will be limited only by the user's needs and the importance of such features to the job tasks. The cost/benefit analysis required to evaluate them for use in work at home may be too sophisticated (i.e., expensive) to incorporate adequately in the system design process. Thus, the decision on these features' use may be made at a "gut" level and based more on superficial aspects than on logical reasons.

Software. Software engineering is a discipline which is coming into full flower. It focuses on systematic methods of developing programs to control systems that must operate in real time (i.e., interact with users, providing desired functions without undesired delay). As a result, the future should hold a continual improvement in the quality of operating system software, including that of telecommunications. The point to note is that the selection of operating software should not be overlooked in selecting a vendor. It becomes even more important when the requirements for telecommunicating include communicating among widely different systems. For example, the hardware and the operating systems may differ at an organization's various computer facilities sites. If so, ensuring that software will be available to allow the system to interact by

exchanging programs and data rapidly and efficiently is a significant consideration but should present no undue difficulty once the problem is recognized.

Security. Most of the work being done to improve computer system security is in the area of software. However, research is also being conducted in one aspect of hardware to improve the reliability of a system allowing signatures to be verified automatically. While the signature is being written, the system keeps track of the pen's two dimensional motion as a function of time as well as the corresponding pressure-time variation (Crane, 1983). Because of western civilization's emphasis on the signature as a primary determinant of many legal status conditions, this technology may allow for security measures which not only are practical and effective but also are acceptable in the eyes of our legal system.

Designing a System: Initial Considerations

When considering specific electronic cottage hardware, the basic problem of matching technological capabilities with corporate needs and human requirements (and humane conditions) must be addressed. In industry, fiscal considerations often appear to receive high priority, and human needs are left to be met within the constraints already imposed. We will presume, however, that the "soft" side of the picture (as discussed later) has been appropriately addressed, and that it is time to examine how to select the hardware to be installed. We will further assume that the potential roles of in-house personnel in defining the new system have already been considered, and that, in addition to eliciting input from all worker levels, any relevant expertise has been identified.

Selecting the designer. It should be apparent that the most efficient assessment will be performed by a designer who is familiar with applying computer peripheral equipment to remote job activities. In fact, if the expert or consultant has designed work-at-home systems for operations exactly like the one being considered by the client, the match will be perfect (technically speaking). Therefore, in surveying the field for appropriate candidates, the client should seek information on the types and number of systems which have been designed by a candidate firm and which are relevant to the current requirements. As much detail as can be assimilated reasonably and used effectively should be requested. On the other hand, the client should not request mountains of statistics from a candidate firm unless they will be used. They may be quite troublesome for the firm to collect, and, if they are extraneous, the wasted effort involved may hamper the client's prospects of getting similar statistics in the future (even from other sources). Such requests could also affect detrimentally the prospective consultant's quotation for the design effort at hand. Any riders and conditions attached to the consultant's provision of information should be scrupulously observed. Breaches of confidentiality are not soon forgotten.

The details given in the following section suggest some of the conditions to be analyzed by those who are considering engaging a consultant as well as by those who plan to rely on in-house expertise. It can be used as a checklist of items to be included in the analysis. However, each situation is in some ways unique, and any external consultant will have to rely on in-house personnel to understand the company in

question. In addition, there are several aspects of the process which can only be treated superficially here but whose importance may become apparent during a specific investigation. These will help to determine whether the design should be conducted by in-house staff or by outsiders.

A word of advice may be helpful at this point. There will be cases when the client has internal expertise on the human (functional and psychological) aspects of the assessment. In these circumstances, an outsider's neutral perspective added to special internal insight (such as familiarity with local politics) may be useful. But if there is in-house technical expertise, no comparable advantage exists in getting an external consultant who excels in hardware evaluation, since the in-house technical staff's judgments are likely to be as objective as any. In fact, the staff's familiarity with local suppliers' practices should be given extra weight. (A consultant's experience with Brand X supplier practices in Bigtown may be quite inappropriate to Backwater.)

The following comments assume that the competence to perform the preliminary design analysis is internally at hand. It should also be clear that any design duties ascribed here to a consultant will have to be borne internally if an in-house design route is chosen. And obviously, if the consultant route is chosen, judgment about the candidates' relative competence will ultimately have to be made.

Surveying the terrain. Having obtained a general appreciation of what new technology can do and after assessing the firm's requirements, stock should be taken of the firm's current resources. Current hardware and software can seldom be ignored or replaced willy-nilly. They must usually be interfaced with the new hardware.

A possible assessment procedure includes the following:

- Do a detailed analysis of job tasks.
- Rate how well the job tasks are being handled currently.
- Evaluate the current technology to determine its weakest and strongest characteristics. Sometimes, the strongest argument for retaining a seemingly archaic method is that it costs the least to use.
- Assess how much state-of-the-art technology (and projected technology at the target implementation date) could improve job performance.

Should the electronic cottage concept appear viable, proceed to select the hardware as discussed below.

Designing a System: Details to be Addressed

In evaluating a consultant's input or in performing the system design, the following aspects of the electronic cottage approach should be carefully considered. In some cases, they are treated as essential questions which must be answered. In others, they represent system design features which should be further examined in light of local conditions.

Computer facility considerations. An initial question with the electronic cottage option is, "Must the central computer be upgraded to handle the additional on-line activity (based on an estimate of the volume of additional computer use)?" Both hardware and software upgrading must be considered in light of the types of terminals best suited to the "home-based" work activities.

An increase in the capability of the central computer to interface with peripheral equipment is likely to be required. For example, more printout material will probably be generated at corporate headquarters during the transition period before the "old-style" supervisors learn to monitor workers by evaluating their reports in video screen format.

Internal communications requirements. Even before local area networks (LANs) become widespread, the evolution of the telephone control centers within firms (PABXs) into computerized versions (CABXs) means that the date a firm first implements its telecommuting may essentially determine whether it maintains dual communications networks — one for voice and for modem-handled terminal data transactions; one for higher speed data and special large band-width information transfer requirements such as high speed data, facsimile units (FAX), videoconferencing, and high-volume multi-media traffic between separated corporate locations (Arcus & Menard, 1984). It should be noted that voice and data at a variety of bit rates are now combined in digital form on public and private trunks (i.e., connections between major urban centers).

For the private network which extends to widely separated sites, communication needs can be supplied by the General Switched Telephone Network (GSTN) or by leased facilities. The former has traditionally charged for local service on a flat-rate basis and for long distance on a distance-sensitive one. Deregulation of the telephone industry in the United States (and consideration of similar changes elsewhere) has created pressure for balancing rates. The present imbalance is due to

subsidization of local service by overpriced long-distance charges. This may result in Local Measured Service (LMS) charging schemes, with consequent increases in the cost of local telephone service, particularly for large-volume users. If this comes about, GSTN methods of providing short-range, off-site access to computers will become less attractive. The telephone companies can be expected to try to phase in these rate changes in such a way as to "snag" as many business users as possible on the GSTN method.

A possible least-cost connection scenario for private networks in these circumstances may consist of direct links by microwave, radio, or satellite between remote work stations and the central facility, with the particular choice dictated by the distance involved. If there is a significant imbalance in information flow, these links might be restricted to the high-volume direction. For work-at-home jobs which entail concise decision feedback by the worker after assimilation and analysis of large quantities of information, this would be the outbound link (i.e., from central to remote). The upstream, low-flow direction could use the more expensive GSTN. For jobs which entail the at-home worker's entering large amounts of information into the central facility but getting only small amounts of feedback (e.g., acknowledgments of correct data entry and approvals by superiors), the situation would be reversed.

The flexibility of satellite networks may be augmented by the impact of the direct broadcast satellite on the required hardware's availability and cost. Home satellite earth stations may be nearly as ubiquitious in a decade or so as the telephone is now. Thus, a modest additional investment

in hardware could provide two-way communication capability, making the resulting and probably wideband channel more useful for communication functions.

External communication requirements. Basically, if the public networks are being used for corporate communications (voice, data, FAX, and video), there is inherent access to external communications. If the private network option has been chosen, the external interfacing requirements must be considered.

Options include using the GSTN from any work station as required, using dedicated minicomputer communication controllers or gateways to the GSTN or to private networks (e.g., Tymenet, Telenet, Datapac, CN/CP Telecommunications) which may be associated with the host computer(s) or CABX, and using leased line connections from the public networks as required.

Consideration should be given to optimizing the relationship between the internal corporate data base and the external data bases (e.g., Compuserve, The Source, Dialog, QL Systems) and Videotex systems (e.g., Infomart, Infoglobe, Qube, Grassroots) that are used by the staff. Although compatibility considerations may influence the internal database design, it is more important to ensure that there is minimum duplication, particularly of content which must be updated frequently.

Few organizations have accumulated comprehensive statistics on such things as the frequency with which their staff accesses various data bases. The newer telephone systems automatically collect and report similar information for communication activities using the CABX. In any

case, the changes associated with telecommuting may mean that any such historical data cannot be easily translated into planning for the new work-at-home environment. Therefore, serious thought should be given to acquiring operating system software that can assemble such information in addition to providing routine monitoring of system activity. It will prove to be invaluable when the system structure is next revised. Furthermore, later generations of operating system software are expected to be capable of optimizing system operation, in the sense that the accumulated history of system use and current rate structures will dictate the particular mix communication channels which are selected for both voice and data information flow within and external to the corporation.

Work stations. With the particular job functions which must be performed at each site in mind, the work station equipment complement may include VDTs and coupler modems when access is through the GSTN. The standard bit rates currently usable are 300, 1,200, and (in some cases) 9,600 bits per second. As the Integrated Services Digital Network (ISDN) becomes a reality, 64 kilobits per second will probably be the standard rate from an individual telephone handset when used for data. (In fact, voice signals will probably be digitized at the handset.) The VDTs and associated peripheral equipment needed for the job functions at the various work sites may require sufficient local intelligence to allow off-peak communication of large amounts of data between the remote site and the central facility, preferably on an unattended basis.

The work station's peripherals might include some of the following:

- Extra memory and stand-alone processing capability for the simpler job functions, with only intermittent exchange of data.
- A hard-copy unit for a clerk or secretary authorized to issue paper documents to organizations that are not yet using computer communications fully.
- A graphics input device (e.g., digitizer tablet, touch-sensitive screen, cursor controller, digitizing video camera) and a graphics display unit for technical and report-preparation staff.
- A piece of manufacturing hardware for decentralized computer-assisted small-scale manufacturing operations conducted in a garage or out-building.
- A microphone (and associated software) to allow access to a word-recognition system.
- A voice synthesizer (and associated software). . . .

This list might be extended indefinitely on the basis of specialized requirements associated with specific jobs.

Software. The software requirements of the work-at-home system must not be underestimated. It is, of course, important to ensure that all the job functions and data transfer needs can be met. Basic communications software, available from a variety of suppliers, may readily be used. Some of the software needs that are particular to the work-at-home situation will have to be addressed with more careful consideration.

Information transfer. Exchanging files between the central computer and remote work stations (up- and down-loading data) should be no major problem, but there may be certain aspects of information transfer which must be provided with custom software. This is particularly the case if the automatic transfer and execution of programs during unattended operation (e.g., overnight) is required. The incorporation of electronic

messaging in a style that is consistent with internal communications practices is usually desired. For example, computer-mediated conferencing has been found by some to contribute to synergistic relationships among those participating, but not all groups trying it have liked it (Kerr & Hiltz, 1982).

Graphics. The North American computer communications industry has developed a standard for graphics information interchange, the North American Presentation Level Protocol (NAPLPS). This is an alpha-geometric convention for representing graphics -- i.e., drawings are defined by information on their elementary figures, rather than using a point-by-point (pixel) approach. Thus, a circle is defined by its radius, the location of its origin, the color in which it is to be drawn, and whether or not it is filled or is simply an outline. The advantage of this technique is that it can result in significant economies in digitally transmitting and storing graphic information. The technique does require that the display terminals be intelligent devices which can decode these picture description instructions, but the cost of such devices is falling, along with the costs of memory and digital electronics generally. In fact, a NAPLPS decoder microchip is expected to be available before the end of 1984. Furthermore, microcomputers are being conscripted for use as Videotex terminals in ever-increasing numbers (Chang, 1984).

Of particular interest to the electronic cottage context is the capability that NAPLPS provides for workers at separate locations to communicate using a "common visual space." This notion consists of each worker being able to manipulate the features of a picture seen by both

workers on their display screens. This technology is now used by Videotex and Teletex systems (i.e., Telidon) for accessing visually-oriented data bases, but the real-time visual interaction it enables can also be very useful in remote-work applications involving plans, graphic designs, and so on that are difficult to conduct in a text mode of interchange.

The implementation of this technology has been slow, due to the circular problem of getting a significant number of terminals onto the market at reasonable prices when the market demand for these terminals is small because of the paucity of high-quality, broadly applicable database material. Meanwhile, the development of the database material is constrained by the limited availability of terminal equipment and the limited number of prospective users. As this cycle becomes defeated, the work-at-home option will be as feasible for visually creative people as it is for those who are creative with words or numbers.

Crash recovery. Breaks in communications paths may be a particular problem with the electronic cottage option. In addition to the computer system crash recovery capability normally available with most software, special operating system routines which can provide for recovery should be given consideration.

Security. System software which implements various security measures to protect against unauthorized access should also be included. The degree of sophistication (and thus expense) necessary will be dictated by the value or sensitivity of the information available through the system. The most basic levels of protection available will normally provide sufficient safeguards against the straightforward use of computer resources (i.e.,

processing power) by unauthorized personnel. A more detailed examination of this issue is provided below.

Training. It must be recognized that the electronic cottage option will require some change on the part of the relocated worker. While most of the undesired and unpopular aspects of the change should have been weeded out, this weeding probably cannot be perfect. Thus, any remaining negative conditions associated with the transition should be ameliorated by special measures. One such measure would be a computer-based training system which introduces the staff to their new environments in an operator-friendly manner.

The new types of terminals which are part of the system will often be accompanied with computerized training packages covering the mechanics of operation. The initial decision on the purchase of the terminal equipment should include some weight for the availability of such packages. Training more specifically oriented to the job functions required by the organization will have to be met through customized packages. However, these too can be considered as part of a comprehensive terminal purchase agreement (at least from some suppliers), in order to be obtained as economically as possible. When these packages are designed, future employees who will be new to the organization should be considered as well as the current staff being reoriented. If the total operation includes a significant number of new employees as part of the change, this training requirement may be more readily recognized and seen as immediately cost-effective.

Physical system integrity. Firms may have to address a certain uneasy feeling by some levels of management over locating company-owned equipment in workers' homes. This will be especially true in cases where there have been adverse personnel relations.

It goes without saying that implementing a work-at-home option presupposes trust in the workers so reassigned. If this condition is not met, it may not be wise to make the change. If the trust condition is fulfilled, some of the loyalty-building activities mentioned in the next part may be appropriate.

Legal requirements regarding the safety of the workplace may affect the equipment's physical environment. Suitable insurance policies may satisfy unresolved concerns.

Security. Fundamentally, the security issue entails deciding on the desired level of protection against the potential computer criminal and determining whether the organization's costs (in both dollars and inconvenience) are warranted. The measures mentioned earlier are all available, awaiting only a decision to use them. As signature (and speaker) verification schemes penetrate the user community, even vulnerability to sabotage initiated by employees can be reduced significantly.

Conclusion

The technical details discussed here are presumed to be incorporated into a sound design process. Some of the aspects considered are particularly applicable to the telecommuting work style. If they are handled appropriately, very effective use of the available hardware and software should result.

HUMAN IMPLICATIONS OF THE ELECTRONIC COTTAGE

Electronic home work is one category of telework; i.e., of work that is done at a distance from the central work organization and that relies on telecommunications. Telework includes not only work done at work stations in the home, but also work done in multi-employer neighborhood centers at stations which the workers can use to establish contact with supervisors, coworkers, and computer installations of their particular organizations. And telework also includes work done in satellite centers set up by individual employers to bring the work closer to their employees' residences.

However, while electronic home work is only one category of telework, it encompasses a wide variety of work arrangements. Perhaps the most salient distinction among these is that between professional and clerical home workers — between, on the one hand, the work of those such as systems analysts, writers, editors, planners, designers, consultants, programmers, and some managers whose jobs are largely internally defined, and, on the other hand, the work of clerks and secretaries whose jobs are clearly and externally defined. This distinction overlaps with others; specifically, with the dichotomies of "elite" work versus "routine" work and self-employment versus external employment. Professional home workers are more likely than clerical workers to engage in nonroutine work and to be self-employed.

These distinctions are widely made and generally useful, but that should not obscure the fact that they raise problems. For example, why should the work of an accountant who helps wealthy clients avoid taxes be called elite, and that of the secretary who performs unnoticed but

complex feats of memory and interpersonal manipulations be called routine? Another problem is raised when these distinctions overlap with others, such as the distinction between full-time and part-time work.

Thus, electronic home work can assume a number of forms that manifest themselves in different jobs and with different types of workers. And what results in advantages, or benefits, in one case may produce disadvantages, or costs, in another. The remainder of this paper will address these benefits and costs, examining them on three levels — the individual worker, the work organization, and society at large. But as noted here and below, each work-at-home situation will differ somewhat. The ensuing analysis should be read with that in mind.

Costs and Benefits to the Worker

What do workers who would normally pursue their functions in a central office have to lose or gain by working at home? The traditional office differs from the at-home work station in that the former is probably not completely automated, provides a social environment consisting of the on-site supervisor and coworkers, and requires a daily trip to get there and back.

The costs and benefits that emerge from a comparison of home workers and traditional workers seem to apply generally. There, are, however, differences in the <u>degree</u> to which these costs and benefits play a role in the case of full-time salaried clerical workers, part-time workers, workers paid on a piece-rate basis, and independent contractors doing clerical or professional work.

For example, while the daily trip to the central office may be time-consuming and frustrating, it provides many informal and unexpected opportunities to learn. The opportunities for chance insights are greater with public transportation, but even driving affords a changing spectacle, perhaps a parade of billboards, that stimulates thought processes. This type of input is important to every person, but its impact on work activity is bound to be greater for the professional worker than for the clerical worker.

This section focuses on immediate, specific costs and benefits to individual workers, as summarized in Table 1. Broader social consequences

Table 1. Possible Costs and Benefits of the Electronic Cottage Option for Employees

Costs	Benefits
Various costs (redesigning home, meeting safety regulations, having insurance)	Low or no commuting costs and commuting time
Stress due to role conflicts and unstructured working conditions	Individual autonomy (flextime, flexplace)
Social isolation	Less money spent on clothes and drycleaning
Fewer opportunities for serendipitous insights	Nonwork use of employer-provided equipment
Fewer opportunities for promotion	More relevant performance appraisals (clerical workers)
Electronic monitoring of performance (clerical workers)	

will be examined later. The distinction between the two is not always easy to maintain, however. For example, Mattura (1983) points out a very

serious cost to many electronic home workers: the cost of being paid less than traditional employees. We see this as both an individual and a social problem affecting two large groups and their dependents: the "no choice" worker who can choose between low pay and no pay, and the "trade-off" worker who is willing to accept lower pay in exchange for intangible benefits such as the time saved commuting to the job downtown.

Costs to the worker. The tangible dollar costs to the worker will depend largely on whether there is an employer who pays for required hardware, software, and telecommunication charges. There are other costs which even generous employers are likely to regard as the worker's responsibility. The home or apartment may have to be redesigned; safety standards will have to be met; the heating bill may be higher. Insurance premiums may rise as the home becomes a place of business and as electronic equipment within it increases the value of its contents.

Of greater long-term importance may be the less tangible, psychological costs of electronic home work. It certainly has considerable potential for stress. Women in particular may elect at-home work in order to look after family and house. They may then be expected to function simultaneously as worker, parent, and spouse. This is one aspect of the larger problem of fusing work and home life, and, as discussed in a later section, it has broad social implications. Another source of stress is the unstructured nature of many home work situations: flextime is generally an advantage, but it does require self-discipline. Mustering such discipline

or feeling angry at not being able to do so requires or wastes energy, respectively.

The objection to electronic home work most frequently raised by potential home workers is that it does not meet the social needs satisfied by the traditional workplace through coffee breaks, lunch periods, the occasional after-work jog or bowling game with a companion, and so forth. However, much more than social needs are involved in the central office's social interaction. As Wynn (1979) points out, office conversation is an important information medium which, among other things, provides a constant environment of informal instruction.

Related to the fear of social isolation is the possibility, mentioned earlier, of reduced opportunities for serendipitous insights. The daily excursion into the world outside plays an important role in learning and gaining insights. The urge of many women to escape the home results in part from a need for the informal, random learning opportunities provided by a crowded bus or street or by impromptu discussions around the office watercooler. And there is another related but different fear for the employee: the fear that being out of sight, one will be out of mind when management considers raises and promotions. This perception on the part of the employee is quite justified: management tends to promote people with firm handshakes and steady gazes, rather than an abstraction producing consistently good work at some remote terminal.

A final cost to the home worker is that the employer's computer and communication system may become a relentless monitoring system, counting every keystroke and demanding explanations for every period of inactivity.

(Big Brother may be watching clerical workers more closely than professional workers — the former cannot argue that they had to reflect on a decision or spend time looking up information in various nonelectronic sources.) This is the reverse side of the benefits of flextime discussed below, and it is a problem faced not only by electronic home workers but also by employees in the increasingly automated office.

Benefits to the workers. In order to provide incentive for coping with the necessary changes in working style associated with the electronic cottage approach, "perks" which the company is willing to provide at modest marginal cost increments per worker should be considered. Fringe benefits such as computer games capability (the terminal hardware aspects in addition to the software availability), access to consumer-oriented data bases and transaction-processing systems, and subscriptions to computer-based learning opportunities can improve the quality of working life and increase work loyalty. Some of these benefits — for example, providing a computerized instructional package on skills for a higher level job function — could be quite "leading" on the part of the employer. On the other hand, the employer would not be likely to make job search services a part of such a package.

However, it should be noted that benefits which have absolutely nothing to do with the new technology may be more appealing to a home worker. In addition, in most instances the most immediate benefit to home workers is that they no longer need to commute to work. The costs of the daily trip to and from work are saved, and considerable time can be gained. The time gained is particularly significant if the worker must

start work at some precise time and if the hazards of rush hour traffic require allowing considerable slack in order to ensure punctuality.

Here too, the most obvious advantage is not necessarily the most important one. The electronic cottage offers at least the possibility of two advantages that attract qualified workers and increase work satisfaction. These are flextime and flexplace. Many at-home workers are able to arrange their work around the responsibilities of child-rearing, shopping, and so forth. This is particularly important in the single-parent and the dual-career household. Also, the location of the home can be determined by considerations pertaining to the sphere of home life (e.g., nearby parks, quiet neighborhood, clean air, good schools, convenient shopping, etc.) rather than considerations pertaining to the sphere of work (location of freeways, distance from workplace, availability of parking downtown, bus routes and schedules, etc.). This increase in individual autonomy is likely to be much greater for middle-class workers than for lower-class workers. The latter are unlikely to have much choice in selecting the location of their homes, and they also may not find their home environments to be particularly enticing.

Along with freedom of choice, electronic home work can provide other benefits. Some home workers report that they spend less money on clothes and on drycleaning. Computer equipment supplied by the employer may be available for nonwork purposes; in particular, for educational use. (This potential benefit has many implications, ranging from positive ones such as providing access to the "wide world of electronics" to negative ones such as pressure on children to do a share of routine keyboarding.) There is

bound to be less harassment at work, sexual or otherwise, when all the manager sees is the work done, not the person doing it. The at-home worker, being out of sight, may have fewer prospects of promotion, but there is also an outside chance that performance evaluations will benefit from a clearcut distinction between the person and the performance, a chance which could work in the favor of some women and minority group members. (This assumes that fairly objective performance indices are available, but under many conditions, that assumption is a tenuous one.)

Costs and Benefits to the Employer

We now move to the level of the work organization. A small matter of definition arises here. The work organization really includes both management and employees. But the term is also used in a more specific sense to refer to management — to the employer alone. We use the term in the second sense in this section.

Table 2 lists potential costs and benefits which an employer implementing electronic home work arrangements should consider. Here too, some fairly arbitrary decisions have to be made in classifying costs and benefits as pertaining primarily to the employer, rather than to the employee or to society at large. Some of the cost/benefit relationships among the different levels — among employers, employees, and society — will be pursued in the section on broader social effects.

Table 2. Possible Costs and Benefits of the Electronic Cottage Option for Employers

Costs	Benefits
Supervision of employees at a distance	Increased efficiency of routine work
Cost of purchasing or leasing equipment and services	Increased effectiveness of nonroutine work
Cost and time of revising office procedures and retraining employees	Less office and parking space needed
Costs and time spent dealing with regulatory agencies	Use of telecommunication facilities during off-peak hours
	Lower labor costs
	Greater ability to retain qualified employees

Costs to the employer. The idea of supervision from a distance does not excite managers to great enthusiasm. One of their major concerns about electronic home work is that it will make their task of supervising workers more difficult. As we have seen, there is also a problem from the employees' perspective, although for quite a different reason. Clerical workers in particular have some reason to fear that they will be monitored by relentless electronic systems.

To what extent supervision at a distance will be a problem may depend on the kind of work being done. Routine jobs are generally easier to monitor than nonroutine ones. This point is related to the productivity implications of electronic home work and will be dealt with below. To what extent supervision at a distance will be perceived as a problem is a

different matter. That depends not only on the nature of the work activities to be supervised, but also on management style.

There are said to be two basic management or leadership styles. One stresses performance; the other, maintenance of the organization and hence its "human resources." These styles concern how managers seek to assure satisfactory productivity levels, and the styles affect how much and what kinds of work managers are likely to allot to home workers.

This dichotomy of leadership types can be exemplified by its earlier and later incarnations. One of the earliest forms the dichotomy took was the distinction by McGregor (1966) between (a) organizations that assume that workers are not inclined to work hard and need to be supervised carefully, and (b) organizations that assume that workers can be trusted to make intelligent choices and that they must be consulted when decisions concerning their work are made.

Among the latest forms of this dichotomy is that presented by Pascale and Athos (1981). According to these authors, the hard aspects of management consist of structure, strategy, and systems; the soft aspects consist of skills, staff, superordinate goals, and style. The former pertain to production in the traditionally American, relatively narrow sense; the latter refer to maintenance of the work organization in a broader sense that includes the long-term ability to produce.

Preference for one of these management styles over the other is partly a function of the new manager; i.e., of his or her previous experience, and perhaps of personality. But it is also a function of the situation — in particular, of the tasks that have to be faced. This means that styles can

be changed, but not overnight. Some retraining and personnel selection may be required to accommodate electronic home work, since supervision at a distance is much more likely to be perceived as a problem by performance-oriented rather than maintenance-oriented managers and supervisors.

The costs associated with equipment and services are more visible than those associated with working out new supervisory approaches. The types of equipment available have been discussed in the section on technology. These costs are likely to be substantial, but they depend on rapidly changing conditions in the marketplace -- conditions that are beyond the scope of this paper.

While supervising at-home employees appears to be a major concern of employers contemplating the introduction of electronic home work, there are additional disadvantages or costs associated with this type of work; in particular, the need for revised office procedures. The procedures for scheduling, distributing, and integrating work assignments are likely to be more complicated when the assignments are carried out in many dispersed locations. Retraining will be required, not only of the at-home workers but also of the managers. Training managers to communicate clearly rather than ambiguously is especially important when workers are unable to ask relatively directly about the material they are supposed to process.

Beyond that there are regulatory costs — the costs incurred because the organizations introducing electronic home work are breaking new ground. Regulations governing traditional work procedures and labor relations often do not fit electronic home work. In many cases, expertise

on its legal aspects will have to be developed; legal advice will have to be sought; and lengthy negotiations with government departments, ranging from municipal health authorities to the Internal Revenue Service, can be anticipated.

Benefits to employers. Productivity increases are probably what organizations most fervently hope to get in return for taking the fairly drastic step of implementing electronic home work. Productivity is usually what makes a work organization consider such major departures from past practices. Often, the aim is a fairly unsentimental ("businesslike") one of reducing inputs or costs and increasing outputs or benefits. Thus, the impetus for trying new directions is usually a concrete fact: a bottom line that does not please the stockholders or painful competition from domestic or foreign enterprises.

While one can envision a future in which factory workers supervise assembly lines from their homes, telework in general and electronic home work in particular are at this time the province of the information-handlers. It is in the tertiary or service sector -- in insurance, banking, programming, designing, and so forth -- that the implications of electronic home work for productivity are of greatest interest.

Productivity in the basic, quantitative sense is related to the hard aspects of management of the Pascale and Athos model. It is the pragmatist's delight, the bird in the hand. It is tangible. It focuses on what is measurable, usually in dollars. How many widgets have been produced? How many lines have been "keyboarded," records updated, insurance claims entered?

Productivity beyond quantity is related more to Pascale and Athos's soft aspects of management — to issues of maintenance and capacity to produce in the future. This is the productivity we have in mind when we speak of "productive meetings," "productive ideas," and so forth. It refers to factors such as the improved quality of goods produced and the production of intangibles such as satisfaction, be it on the part of the consumers or clients or on the part of the workers themselves. It is what we have in mind when we ask such questions as, "How much is a quicker decision worth? How much satisfaction has been generated?" (The latter might be estimated in the utils of the decision theorists, or possibly in "sats" [one unit of satisfaction] or even "thrills.")

The distinction between hard and soft productivity relates not only to managerial styles but also to the types of work being done in the electronic cottage. Jobs requiring mostly routine work are what Maier and Verser (1982) call "production jobs," while those calling mainly for nonroutine activities are Maier and Verser's "nonproduction jobs." They define the former as jobs for which productivity can be assessed in purely quantitative terms, and the latter as jobs in which the work's quality is a critical variable.

So far, electronic home work involves both extremes of the routine versus elite work continuum (Olson, 1982; Pratt, in press). Most American managers are generally of the performance-oriented type. This may mean that they have no problem with clerical home workers whom they can pay by the unit produced; that they consider professional workers to be beyond the ken of systematic productivity assessment, regardless of whether the work

is done at home or at the office; and that they see the workers in between these two extremes as posing the greatest problems for productivity assessment.

Does electronic home work increase productivity? This depends on the circumstances. What one worker may perceive as freedom from distraction and interruptions at the office may mean increased distraction and interruptions if spouse, children, neighbors, and postmen happen to demand attention all day long.

The real question, then, is this: Does electronic home work encourage circumstances which increase productivity? No doubt there are many in-house surveys and evaluation studies, but the information reported in academic sources is limited. McClintock (1981) provides some preliminary evidence that both hard and soft productivity could increase with the introduction of electronic home work. McClintock distinguishes between efficiency and effectiveness in the context of electronic home work. He regards efficiency as the ability to do routine tasks with little time and effort and effectiveness as the ability to produce high-quality nonroutine work. Surveying a sample of twenty professionals, ranging from six who did not work at home to others who did most of their work at home, he found that working at home was associated with reports of increased efficiency in routine tasks and of increased effectiveness in nonroutine tasks.

Lower costs are another anticipated benefit to employers, one that is closely linked to increased efficiency. Overhead costs may drop as less office and parking space is needed, as computer use is spread over a longer period each day, and as telecommunication facilities are used in the

evening and at night when they are considerably cheaper (or at least will be cheaper until too many users discover off-peak hours).

Labor costs may also drop significantly, especially if the home workers are primarily nonunionized part-time workers who are not entitled to many fringe benefits and are willing to work on short notice as needed by the company. Not only can the employer then reduce the cost of fringe benefits and the time required to administer them; the employer can also acquire much greater flexibility than that afforded by a predominantly full-time, salaried workforce. In most cases, these benefits to the employer are costs to the employees. Such benefits thus have to be looked at from a broader point of view; one that takes the workers' interests into account. A discontented workforce is something even the most performance-oriented managers would like to avoid.

The ability to retain qualified employees is one of the specific benefits mentioned by companies as a reason to experiment with electronic homework. Training is expensive, and in some areas, such as systems analysis, the supply of skilled personnel is limited. The benefits to the employer can be especially great in the case of employees who have become disabled, since they are already trained to meet specific needs of the employer.

Broad Social Implications

Table 3 lists some of the potential effects on society of implementing electronic home work on a large scale. They pertain primarily to the legal framework governing the sphere of work; to the social costs inflicted on

society and the environment by the current modes of working; and to the relationship between work and life in the broad sense of Marx's "sphere of necessity" and "sphere of liberty," respectively.

Table 3. Possible Costs and Benefits of the Electronic Cottage Option for Society

Costs	Benefits
Imbalance between employer and employee power	Ecological benefits: conservation of resources, reduced pollution
Loss of option to segment work and personal life	Reintegration of "technoeconomic structure" and "culture"
	Shift from centralization to decentralization
	Shift from hierarchical structure to networking

Imbalance between employee and employer power. The regulatory environment both affects and is determined by the introduction of electronic home work. The issue of the costs incurred by pioneering organizations that try to make radical changes was touched on earlier. Of interest here are the likely effects on the regulatory environment of efforts to introduce electronic home work on a large scale.

Any change as dramatic as shifting work from the central office to the workers' homes is bound to run into conflict with the many laws and regulations which seek to coordinate, and often constrain, the world around us. Painful transition is likely as the conflicts are identified and as the rules are modified to fit the conditions created by advancing high technology. Not only may laws currently on the books be changed because

they inhibit electronic home work; new laws are likely to be introduced to encourage this type of work.

There is considerable concern, particularly in union circles, that statutes and regulations protecting workers' interests will be eroded by changes made to accommodate electronic home work. These protections concern wages and working hours, fringe benefits (especially company pensions and social security contributions), working conditions, health and safety, and child labor. Pressure to change laws and regulations — for example, pressure emanating from the desire to use new technology and implement home work projects on a large scale, particularly given a spirit favoring deregulation — constitutes a threat to many who remember that labor power started to balance entrepreneurial power only after large groups of workers in large, centralized plants were organized. An example of what labor fears is the relaxation of a regulation based on the federal Fair Labor Standards Act (1938). This act contains provisions banning home work in seven clothing industries, and the Department of Labor has attempted to lift the ban on one of these industries, the "knitted outerwear" industry.

The Federal Social Security Act (1935) is a source of wide-ranging provisions relevant to electronic home work. In general, employers and employees contribute equally under the act and its various amendments to provide old-age, survivors', and disability insurance.

The rules governing who must pay for social security coverage and determining employers' payroll taxes for state unemployment insurance plans and so forth require that the home worker be identifiable

as an employee or as self-employed. Often, however, he or she is a hybrid at this stage in the evolution of the electronic cottage option.

The Fair Labor Standards Act helps to determine who is an employee and who is an independent contractor. Employers like to consider the home workers as independent contractors in order to reduce recordkeeping, to avoid the costs and red tape associated with fringe benefits such as social security contributions, and to avoid complications introduced by overtime (in particular, the requirement explicitly stated in the act that the pay rate be time-and-a-half after a 40-hour work week). The act suggests that if the workers supply their own equipment, they may be independent contractors (e.g., entrepreneurs or, to use the new term used by Pinchot [see Aeppel, 1983], intrapreneurs doing contract work for one corporation).

The Fair Labor Standards Act also contains minimum wage provisions. These raise the question of what the home worker's real wage is. In the office everything is supplied, from erasers to office equipment maintenance. At home the employee may incur certain costs. Is the real wage what is left after these costs have been deducted?

Relevant child labor provisions are contained in both the Fair Labor Standards Act and the Federal Public Contracts Act. There are fears that computer home work will erode these provisions, for bright children and youths will be tempted or pushed to do a share of the routine work at the home work station. Perhaps the urge to earn pocket money in that fashion will be stronger than the traditional urge to do so by delivering papers or babysitting.

Since the U.S. Constitution grants to the states all powers not explicitly assigned to the federal government, there are numerous state laws that bear on electronic home work. There are state child labor laws (particularly regarding school attendance), industrial home work laws, unemployment insurance laws, and health and safety regulations. The states, in turn, delegate various powers to their municipalities, and thus many zoning regulations and regulations affecting such concerns as health and safety vary from place to place. Some communities eager to attract new employers may be much quicker than others to change their regulations.

Labor is concerned about such changes. Its leaders are watching carefully to make sure that the statutory protections now provided to workers remain in place. Labor leaders see the efforts to drop the ban on home work in the "knitted outerwear" industry as just the beginning, and they worry about "telescabbing" and "electronic sweatshops" (Eder, 1983). The Service Employees International Union of the AFL-CIO "has asked the Department of Labor to ban computer home work entirely" (Webb, 1983), and it gloomily anticipates a return to unsafe working conditions and violations of wage and child labor laws.

Ecological benefits. Next to Alvin Toffler, the name most frequently associated with the electronic cottage is probably Jack Nilles. Although Nilles's primary concern is with the more general issue of decentralizing work, the effects of decentralization that he and his colleagues foresee apply to the electronic cottage as well. (The electronic cottage is, after all, an extreme variant of both office automation and work decentralization.)

In their 1976 book, The Transportation-Telecommunications Tradeoff, Nilles and his colleagues performed a number of cost/benefit analyses for a variety of work decentralization options involving satellite work centers. The benefits to society loomed large at the time, a time of rising oil prices and decreasing oil supplies. These benefits are still critically important even though oil supplies appear adequate for the moment. Conservation of oil reserves remains vital, not only because conventional nonrenewable energy supplies are being depleted and nuclear energy has run into the twin roadblocks of runaway costs and an inability to dispose safely of radioactive waste, but also because oil has much better uses as feedstock (especially as a basis for pharmaceutical and food production) than as fuel. The electronic cottage option offers other ecological and resource consumption benefits: lower pollution levels are of incalculable importance today, just as they were at the time of the analyses of Nilles et al., and the prospect of spending less money on highway systems that are fully used only during morning and evening rush hours is particularly interesting at a time of growing public deficits.

Fusion of work and life. Bell (1976) argued that work and life constitute two very different spheres: work is part of the technoeconomic structure; life unfolds within the sphere Bell calls the "culture." To Bell, the culture of post-industrial America propagates values pertaining to individual satisfaction which conflict with the demands of the technoeconomic structure for restraint and discipline.

It is likely that widespread electronic home work would reduce this gap between work and life, but whether that is good or bad depends on the

circumstances. One possibility is that bridging the physical distance between work and home will remove an important option for many workers: the option of segmenting their existence into the spheres of work and home. This segmentation may serve two quite different purposes. According to Libby (1969), David Riesman has suggested that the gap between work and home life serves the purpose of escape from work, while Herbert Gans has noted the possibility that workers may wish to escape from home to the workplace.

The positive aspect of the fusion of work and life is emphasized by Toffler (1980), who not only coined the term "electronic cottage" but also is one of the most enthusiastic advocates of the electronic cottage mode of work. He sees it as a way to revive or strengthen the nuclear family by linking work and life. His optimism probably stems from his personal experience as a writer pursuing his creative keyboarding at home. However, work at home is no doubt less rosy for the insurance company clerk engaged in repetitive record updating.

The question of who will benefit from fusing work and life raises the same possiblity as the question of who benefits the most from flextime and flexplace. As noted before, middle-class workers are more likely to welcome such fusion than are the poor, whose homes, sometimes not delightful places to be in any case, may be made worse when they also become the locations of repetitive jobs.

On the whole, however, the contribution of electronic home work toward fusing work and life is likely to have more positive than negative effects. One of Naisbitt's (1982) megatrends, the trend from

centralization to decentralization, is a broad dimension of the social transformation involved here. Naisbitt warmly welcomes this trend, which he defines as including not only a moving away from crowded cities to small towns and rural areas, but generally a moving away from big government, big corporate headquarters, big media, etc. toward local autonomy, dispersion of commercial activity and manufacturing, and specific interest groups. An inkling of what electronic home work may bring, at least for the middle class, can be found in the central Piedmont area of North Carolina (the area of the Research Triangle), described by sociologist John Kasarda (in Giovannini, 1984) as "what urbanism is going to be like in the 21st century: decentralized, multimodal, multiconnective." Along similar lines, Marien (1978) foresees a "devolution of services" -- a moving away from the central "technological service society" to an "agrarian, decentralized society."

More than changes in the physical distance between work and home or in the distribution of population are likely to result from large-scale electronic home work. Homes equipped for electronic home work are also equipped to have access to the wider electronic world in general. They have a direct line, in the literal sense, to that world's data bases, medical services, educational facilities, consumer services, and so on. These homes will be part of what Spinrad (1984) calls the Net, "the world-girdling and all pervasive matrix of communication and data transmission." Although in the interests of security (a topic discussed earlier, in the section on technology) many computer systems are designed to grant or withhold what are aptly called "privileges" to their users,

widespread and relatively unhampered access to the Net may turn out to be one aspect of another of Naisbitt's megatrends: the trend from hierarchy to networking. (Such access to the Net even raises the possibility that social isolation in the electronic cottage is not an issue in the long run. Electronic contact with the rest of the world and with what Spinard calls "audioanimatronic robots" may compensate for the lack of face-to-face contacts with fellow humans.)

Relationships Among Costs and Benefits to Workers, Employers, and Society at Large

Up to this point the costs and benefits of electronic home work have been treated as classifiable into mutually exclusive categories based on level of analysis -- i.e., based on whether they concern the worker, the employer or society at large. The fact that this scheme is oversimplified was mentioned earlier in the context of lower labor costs. Should lower expenditures on wages or salaries be interpreted as a cost to the worker, a benefit to the employer, or a cost or benefit to society? Lower wage expenditures were classified earlier as a benefit to the employer, because this is the form in which the issue seems to arise most saliently in discussions of the electronic cottage. Obviously, however, any of these possible interpretations can apply.

A next step in pursuing the analysis started here might include identifying explicitly which costs and benefits constitute pairs to be traded off against each other, either within one of our three levels of analysis or across two or more of them. For example, within the worker

level of analysis, the benefit of individual autonomy can appear as the cost of stress due to lack of structure. Examples also abound of the often contradictory effects of electronic home work when related across different levels. Management's gain can be the employee's pain (and vice versa); what is an advantage for society at large can be a disadvantage for individuals (and vice versa). For example, fusing work and home may do wonders for some middle-class families and hence for mainstream American society, but this fusion could be a cost rather than a benefit for others who want to keep their work lives and their personal lives compartmentalized because one or the other is a source of stress.

Subsequent analysis might also involve a close look at how people and jobs can be matched in the context of high technology in general and electronic home work in particular. Perhaps some workers have personality traits that permit them to perform better and to experience greater satisfaction with their work when they work at home instead of in the office. Such interest in matching people and jobs raises the traditional issues of industrial-organizational psychology. The first set of issues would relate to job analysis: What exactly do these new jobs done behind video terminals at home involve? A better understanding of the job requirements would raise issues of job design: Can the jobs be changed to decrease social isolation and increase the variety of tasks to be done? Since jobs can only be changed so much to fit them to people, issues related to personnel selection and personnel training would also arise, but here the concern would be to fit people to the jobs.

As this paper has shown, the electronic cottage option has costs and benefits which depend on particular circumstances and their interaction.

Research along the lines described above would help to clarify the types of people and the conditions that will allow electronic home work to produce maximal benefits and minimal costs at the levels of worker, work organization, and society at large. But even at this early stage, it appears that the electronic cottage option offers the potential to improve the quality of many workers' lives.

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